tion knob **18**, e.g., there is relatively little subsequent shifting of the supporting ring **28** out of its newly designed X- axis position, due to the backlash free nature of the channel configuration of the monolithic housing **12**. While the first models were constructed out of anodized aluminum which has a large thermal coefficient of expansion, preferably, the monolithic housing **12** should be made from a zero or low thermal coefficient of expansion material such as the nickel alloy sold under the trademark INVAR. Also, the increased rigidity of this alloy further reduces the cross talk arising from the manipulation of the Y-axis control knob **20**, assuring that the X-axis and Y-axis movement do not interfere with each other. Thus, movement of the support ring **28** may be controlled one axis (X and Y) at a time, with the assurance that the precise nanometric positioning set for one axis will not be disturbed by a subsequent setting a movement along the other axis. Tests performed by the applicant indicates that a 10° turn of the X- axis positional knob **18**, for example, results in displacement equal to the length of one fringe of a helium-neon laser light or 316 nanometers (1.24×10^{-5} inches or 0.0000124 inches) of the support ring **28** with respect to the main frame portion **15**.

FIG. **5** is a cross-sectional view taken along line V—V of FIG. **4** to show the operation of the nanometric displacement mechanism of this invention in the X-axis direction. As the control knob **18** is turned clockwise **48** (from the user viewpoint), the upper portion of the holes **35** (FIG. **4**) of the double L-shaped arm **44** (FIG. **4**) rides the tapered shaft **50** (FIG. **4**), causing movement of the arm **44** about the flexible fulcrum **62**. As the arm **44** moves around the flexible fulcrum **62** (FIG. **4**), the support ring **28** moves along the X-axis (as shown in FIGS. **1** and **3**). Nanometric displacement is achieved by the compound nature of the lever formed by the arm **44** acting in combination with the tapered shaft **50** (FIG. **4**). A spring plunger **64** acts against the large hole **35** in the arm **44** so that after the arm **44** moves, the arm **44** returns to its original position before the tapered shaft **50** was activated. A significant motion reduction is thus achieved by the displacement mechanism with almost no backlash. FIG. **6** shows a cross-section highlighting the thin flexure link **30** which connects the arm **44** to the support ring **28**. The flexure link **30** separates the channels **40** and **42** and provide a relatively strong but flexible link for the support ring **28** to the arm **44**.

Turning to FIG. **7**, there is shown a cross-sectional view of the preferred embodiment of the Z- axis adjustment mechanism **24**. Manual turning of the internally threaded control sleeve **16** puts into motion a series of operations which insures the nanometric and precise movement of the optical fiber holder tube **14** in the Z-axis direction.

As the internally threaded control sleeve **16** is rotated in a clockwise direction, shown by the arrow **74**, the tapered bore **76** at the rearward end of the sleeve **16** is pressed in contact against the round-headed drive pin **78** positioned radially outward from the sectioned lever arm **80** of the flexure lever. The lever arm **80** is linked to the flex pivot lever body **82** through a flexure fulcrum **84**. As the lever arm **80** is caused to swing downward around the flexure fulcrum **84**, the projection flange **86** of the optical fiber holder tube **14** rides along the lever arm **80** against the arm's inner shoulder. The optical fiber holder tube **14** then moves to the left direction **75** by a infinitesimal amount. At the same time the projection flange **86** causes the optical fiber tube holder **14** to move to the left direction **75**, the radially directed shoulder flange **88** presses against the Belleville spring **90** which engages the inside of the adjustment body tube **92**. Thus, movement of the projection flange **86** simultaneously causes compression of the Belleville spring **90** against the inner shoulder of the adjustment body tube **92**. The Belleville spring **90** acts to bias the tube **14** in an axial direction opposite direction **75**, so as to minimize backlash as the tube **14** nanometrically advantages along the Z- axis to the left direction **75**. In this manner, backlash free Z- axis Nanometric displacement is achieved.

With reference to FIG. **8**, an alternative embodiment of the Z- axis Nanometric displacement mechanism as shown in FIG. **7** is illustrated. As an alternative to an optical fiber holder tube **14** of FIG. **7**, nanometric displacement along a Z- axis is achieved by movement of screw **94**. Coarse adjustment of the screw **94** may be achieved by clockwise directional turning of the screw as shown in **96**. Fine adjustment is achieved by clockwise **98** turning of the internally thread sleeve **100**. A tapered bore **102** moves against a round headed pin **104** causing displacement of a lever arm **106** which reciprocally swings about a flex fulcrum **108**. This flex fulcrum **108** presses the lever arm **106** against the projection **110** of the threaded nut **112**, driving the threaded nut **112** in a leftward direction **113**, compressing the Belleville spring **114** against an inner shoulder **116** of the tubular body **118**. In this manner a nanometric displacement of the screw **94** is achieved. The nanometric screw **94** could then be mechanically linked to an optical fiber holder tube like **14** in FIG. **7**, to achieve nanometric Z-axis displacement for the multidimensional nanometric displacement positioner such as that shown at **10** in FIG. **1**.

While the preferred embodiment of the invention is disclosed herein, the scope of the invention is not necessarily limited to the preferred embodiment. Changes are possible and these changes are intended to be within the scope of the disclosure. For example, the particular configuration of the channels formed into the monolithic housing **12** which were chosen to facilitate manufacture may be varied without a substantial change in the principles which govern the operation of the nanometric positioner of this invention. Consequently, the specific configuration of the invention disclosed herein, or the construction of the nanometric position are merely representative, and are deemed to afford the best embodiment for purposes of disclosure and for providing support for the claims which define the scope of the present invention.

What is claimed is:

1. A multi-dimensional fine-adjustment linear displacement apparatus, comprising:

a monolithic housing having a main frame portion, and a support ring movable with respect to said frame portion, said support ring having a central aperture,

said monolithic housing further including:

at least one first lever forming a flexural connection with said support ring, said lever being integral with said housing; and

means for driving said first lever about said flexural connection including a tapered control shaft for displacing an arm of said first lever, and a spring plunger so as to nanometrically displace said sup-